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(54) Method for communication in a bidirectional bus system.

(57) A method for signal transmission and reception by a bidirectional bus system in which plural devices performing the communication of a command and a request are interconnected over a bidirectional bus is disclosed. The method includes the steps of constituting a frame of a transmission signal on the bidirectional bus from an address field for designating addresses of communicating devices and a data field for designating the command or request to be transmitted, and inserting the discriminating information for discrimination between the command and the request at a pre-set position in the data field. The transmission signals having the discrimination information is transmitted over the bidirectional bus to other devices. A communication system employing such bidirectional bus system is also disclosed.

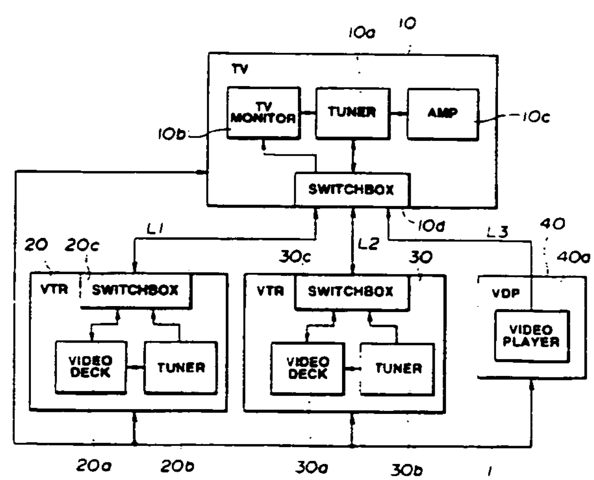

FIG.6

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This invention relates to a method for transmission, a method for reception, a method for communication, and a bi-directional bus system. The present invention is applied to, for example, a system for controlling sub-devices, such as a monitor receiver, a TV tuner or a video deck enclosed in devices such as a television receiver or a video tape recorder, or transmitting the operating states of these devices, over a bi-directional bus interconnecting these devices.

It has recently been extensively practiced to interconnect plural audio equipment or visual equipment, referred to herein as AV equipment, over a video signal line or an audio signal line, referred to herein as an AV signal line, in order to form an AV system.

With such AV system, it is practiced to interconnect the equipment over a system control bus, in addition to the above-mentioned AV signal bus, referred to herein as a bi-directional bus, in order to control the equipment among one another and to transmit data indicating the operation statuses etc., of the equipment, also referred to herein simply as statuses. Illustrative examples of these systems include audio, video and audiovisual systems, domestic digital bus (D2B) as specified in IEC Publication 1030 issued in May 1991 and a home bus system (HBS) as disclosed in "Transistor Technology, special issue, No.30, chapter 7, published by CQ Publications on November 1, 1991. Using a bi-directional bus, the equipment or devices, such as a television receiver (TV), a video tape recorder (VTR) or a video deck player (VDP) control other equipment or sub-devices enclosed in these other devices, such as a monitor TV receiver, a TV tuner, a video deck or an amplifier. In addition, the statuses of the devices or sub-devices are transmitted over the bidirectional bus. With the D2B, for example, a carrier sense multiple access with collision detection (CSMA/CD) is adopted as the bidiretional accessing system.

Thus the communication from a sub-device enclosed in a device to a sub-device enclosed in another device, the communication from a sub-device enclosed in a device to another device, the communication from a device to a sub-device enclosed in another device and the communication from a device to another device, are executed over the bidirectional bus.

The format for transmission signals employed in the above-mentioned bidirectional bus, such as D2B, is now explained. With the D2B, commands or statuses for controlling the sub-devices etc., of the destination of transmission, referred to herein as a control command, is of a frame structure, and is transmitted over the bidirectional bus, as shown in Fig.1.

That is, each frame is made up of a header field 101 designating a header indicating the leading end of the frame, a master address field 102 designating an address of an originating device (source device), a slave address field 103 designating an address of a device of the destination of transmission, that is a destination or receiving device, a control field 104 for designating a control bit indicating the communication under the state of having locked or unlocked the device of the destination of transmission, and a data field 105 for designating the control command or status.

The header of the header field is made up of a start bit 101a composed of a bit for synchronization and a mode bit 101b for specifying the rate of transmission and the number of bytes of the data field 105. The mode bit 101b is made up of 1 to 3 bits and is currently used for specifying a mode 0 for providing the data field composed of 2 bytes at the maximum, a mode 1 for providing the data field composed of 32 bytes at the maximum (16 bytes each for the master and the slave if the data field extends from the slave to the master), and a mode 2 for providing the data field composed of 128 bytes at the maximum (64 bytes each for the master and the slave if the data field extends from the slave to the master), as shown in Fig.2.

The address of the originating device of the master address field 102 is made up of a 12-bit master address for designating the address of the originating device and a 1-bit parity, as shown in Fig.2.

The address of the originating device of the slave address field 103 is made up of a 12-bit master address for designating the address of the originating device, a 1-bit parity and a 1-bit acknowledge data for responding to the destination device, as shown in Fig.2.

The control field 104 has 4-bit control data 104a for indicating the direction of transmission of the control command or the status or the locked or unlocked state, a 1-bit parity data and a 1-bi acknowledge data 104c, as shown in Fig.2. Specifically, the control bits are employed for checking whether the status is being written from the master to the slave or from the slave to the master, whether the originating device communicates with the device of destination under the locked state or under the unlocked state or the destination device, and whether the data is the data per se or the control command, as shown in Fig.9.

The data field 105 has an 8-bit data bit 105a, a 1-bit end-of-data bit 105b, a 1-bit parity 105c and 1-bit acknowledge bit 105d, these being repeated in this order, if so required, as shown in Fig.2. If the data bit 105a is designated #1, #2, #3, ···, from its leading end, and the command is being transmitted, the operation code or OPC "begin 2", indicating the sub-device-related communication, that is the code "BD"h, h indicating a hexadecimal code, OPC "begin 1" indicating the communication via HBS, and an OPC "begin 0" indicating the communication over another bus, that is the code "BB", are designated in the data #1, while operands OPRs for these OPCs are designated in the data #2. For communicating the data, the data are sequentially designated in the data #1, #2, #3, ···, on the

basis of an 8-bit byte.

The OPR for the above-defined OPC, for example, the OPR for the OPC "begin 2", is made up of bits b_5, b_4, b_3, b_2 for identifying the service codes for communication telephony (CT), audio video and control (AV/C) and housekeeping (HK), with the bit b_7 being an MSB, and bits b_1, b_0 for indicating one of the communication from a sub-device to a sub-device, communication from a sub-device to a device, communication from a device to a sub-device and the communication from a device to a device, that is, indicating the presence or absence of the address of the originating sub-device (source sub-device address or SSDA) and the destination sub-device address or DSDA), as shown in Fig.4. The bit b_7 is perpetually 0 and the bit b_6 is reserved for future standardization and is currently set to 1. Specifically, $b_1 = 0$ and $b_0 = 0$ indicate the communication from a sub-device to a sub-device, $b_1 = 0$ and $b_0 = 1$ indicate the communication from a sub-device to a device, $b_1 = 1$ and $b_0 = 0$ indicate the communication from a device to a sub-device, $b_1 = 1$ and $b_0 = 1$ indicate the communication from a device to a device.

A sequence of operations comprising controlling the VTR by the TV transmitting a control command to the VTR, the TV transmitting a request demanding the status to the VTR and receiving the status from the VTR as an answer to the request for confirming the operating states (status) of the controlled VTR, is hereinafter explained.

Referring to Fig.5, the TV formulates a command frame in which the master address bit is set to the TV address, the slave address bit is the VTR address, the control bit is set to "A"h indicating the code of writing the command under the locked state, data #1 is set to e.g., the code "BD"h (OPC "begin 2"), data #2 is set to the code "56"h indicating the communication from the device to the sub-device, data #3 is set to the video deck address for the VTR, as the route selection information, data #4 is set to a code "C3"h (command) for playing the video deck and data #5 is set to a code "75"h (OPR) indicating the forward. The TV detects the presence or absence of the so-called carrier on the bidirectional bus and, if there is no carrier, that is if the bus is vacant, the TV transmits the command frame to the VTR and subsequently transiently halts the carrier transmission to open the bus. Thus the control command is transmitted from the TV to the VTR which then starts the reproducing operation. In order to prevent the VTR from being controlled by the control command occasionally transmitted during this sequence of operations from another device to this VTR, the TV controls the VTR to its locked state by the aforementioned control bit in order for the VTR not to accept the control command from such another device.

The TV then formulates a request frame in which the master address bit is set to the TV address, the slave address bit is set to the VTR address, the control bit is set to "A"h indicating the code of writing the command under the locked state, the data #1 is set to a request code, data #2 is set to the OPR for the request code and the data #3 is set to a terminator, as shown in Fig.5B. When the bidirectional bus becomes vacant again, the TV transmits the request frame. Meanwhile, the code of the control command of the data #4 shown in Fig.5A should inherently be different from the request code of the data #1 shown in Fig.5B. However, since there is imposed a limitation in the kinds of the code that may be represented by eight bits, the same code is employed for the control command code and for the request code, and the control command code is distinguished from the request frame by addition of the aforementioned terminator.

The TV also formulates an answer frame in which the master address bit is set to the TV address, the slave address bit is set to the VTR address, the control bit is set to the code "2"h indicating the data readout under the locked state, that is the status readout of the video deck, as shown in Fig.5C, and transmits the answer frame to the VTR. The VTR sets (designates) an answer code, an OPR for the answer code and the terminator in the data #1, #2 and #3, and returns the frame designated in this manner. With the answer frame, in distinction from the above-mentioned command and request frame, the status transmission from the slave to the master occurs in the data frame 105.

The TV then formulates an end command frame in which the master address bit is set to the TV address, the slave address bit is the VTR address, the control bit is set to the code "E"h indicating the command writing under the non-locked state, and an end command is set in the data #1, and transmits the end command frame to the VTR. The VTR is unlocked by the end command frame and enabled to receive control commands etc., of other device(s).

With the above-described conventional bidirectional bus system, it is necessary for the TV to transmit a command frame for transmitting the control command to the VTR and subsequently transmit request frame for confirming the status of the VTR. Besides, since the route selection information composed of OPC "begin 2" is present only in the command frame, the TV needs transmit an answer frame. In addition, the TV has to transmit the end command frame in order to release the locked state of the VTR. That is, with the conventional bidirectional bus system, the TV needs to transmit the command frame, request frame, answer frame and the end command as a set, with the consequence that the traffic is increased while the transmission efficiency is lowered and the communication procedure (protocol) is complex.

In addition, the time consumed since the VTR receives the control command and is again readied for

reproduction until it returns the answer to the request is longer as compared to the rate of communication because of the mechanical operation of the video deck. Since the bidirectional bus is occupied during such time, it becomes necessary for other device(s) to wait for a prolonged time until the bidirectional bus becomes opened.

Furthermore, since the terminator is affixed to the trailing end of the request frame for discrimination between the control command code and the request code, the destination or receiving device, such as the VTR, becomes complex in the processing hardware. Besides, should the terminator be absent by dropout, the request frame tends to be mistaken for the command frame.

In view of the above-described status of the prior art, it is an object of the present invention to provide a method for transmission, a method for reception, a method for communication, and a bi-directional bus system whereby the amount of traffic on the bidirectional bus may be lesser than with the conventional communication method and whereby the transmission efficiency may be improved and the communication protocol may be simplified.

In one aspect, the present invention provides a method for transmission by a bidirectional bus system in which plural devices performing the communication of a command and a request are interconnected over a bidirectional bus. The transmission method includes the steps of constituting a frame of a transmission signal on the bidirectional bus from an address field for designating addresses of communicating devices and a data field for designating the command or request to be transmitted, and inserting the discriminating information for discrimination between the command and the request at a pre-set position in the data field. The transmission signals having the discrimination information inserted therein is transmitted over the bidirectional bus to other devices.

In another aspect, the present invention provides a method for reception of a bidirectional bus system in which plural devices performing the communication of a command and a request are interconnected over a bidirectional bus. The method for reception includes the steps of receiving a transmission signal over the bidirectional bus, and detecting the discrimination information from the transmission signal. The transmission signal has a frame structure comprised of an address field for designating addresses of communicating devices and a data field for designating the command or request to be transmitted. The transmission signal has the discrimination information inserted at a pre-set position in the data field. The discrimination information makes discrimination between the command and the request from each other. The recognition of whether the contents of the data field is the command or the request is made on the basis of said discrimination information.

In still another aspect, the present invention provides a communication system employing a bidirectional bus system in which plural devices performing the communication of a command and a request are interconnected over a bidirectional bus. A source device constitutes a frame of a transmission signal on the bidirectional bus by an address field for designating addresses of communicating devices and a data field for designating the command or the request to be transmitted, inserts the discrimination information at a pre-set position of the data field for discriminating the command and the request from each other, and sends out the transmission signal with the discrimination information inserted therein over the bidirectional bus. A destination device receives the transmission signal over the bidirectional bus, detects the discrimination information from the transmission signal and recognizes whether the contents of the data field is the command or the request based upon the discrimination information.

In yet another aspect, the present invention provides a bidirectional bus system comprising a plurality of devices performing the communication of the command or the request. These devices include transmission signal forming means for constituting a frame by an address field for designating addresses of communicating devices and a data field for designating the command or the request to be transmitted and inserting the discrimination information at a pre-set position of the data field for discriminating the command and the request from each other to form a transmission signal. The devices also include bus outputting means for outputting the transmission signals formed by the transmission forming means over the bidirectional bus, bus inputting means for receiving the transmission signal over the bidirectional bus, and control means for detecting the discrimination information from the transmission signal received by the bus inputting means and recognizing whether the contents of the data field is the command or the request based upon the discrimination information. The devices are interconnected over the bidirectional bus.

In sum, the source device constitutes a frame of a transmission signal on the bidirectional bus from an address field for designating addresses between communicating devices and a data field for designating a command or a request to be transmitted, and sends out the transmission signal over the bidirectional bus after insertion of the discrimination information at a pre-set position in a data field for discriminating the command and the request from each other. The destination device receives the transmission signal over the bidirectional bus and detects the discrimination information from the transmission signal. The destination device recognizes whether the contents of the data field are the command or the request based on the discrimination information. Thus the hardware and the processing software of the

source device (originating device) may be simplified as compared to the conventional system. Since the discriminating information is inserted at other than the trailing end of the frame, the possibility of dropout of the discrimination information is low, thus rendering it possible to prevent the request frame from being mistaken for the command frame.

The source device also designates the command, request, answer to the request or the device status in the data field, and sends out the transmission signal after inserting the discrimination signal discriminating the command, request, answer to the request and the automatic status transmission from one another in the transmission signal. The destination device discriminates the contents of the data field as being the command, request, answer or the automatically transmitted status based upon the discrimination signal. Thus it is possible for the devices to optionally send out the command frame, request frame, answer frame or the automatic status transmission frame irrespective of other frames, thereby reducing the traffic on the bidirectional bus and improving the transmission efficiency. On the other hand, the communication protocol may be simplified. In addition, since the frames may be sent out optionally, the bidirectional bus may be prevented from being occupied for a long time period relative to the rate of communication to reduce the traffic on the bus in contradistinction from the conventional bidiretional bus system in which the bus is occupied for long until the answer to the request is returned.

The invention will be further described by way of example, with reference to the accompanying drawings, in which:-

Figs.1 and 2 show a format for a conventional D2B frame.

Fig.3 shows the function of a conventional control bit.

Fig.4 shows the function of the OPR of a conventional OPC "begin 2".

Fig.5 shows the formats of the conventional command, request and answer frames.

Fig.6 is a block diagram showing a practical arrangement of a bidirectional bus system according to the present invention.

Fig.7 is a block diagram showing practical arrangements of the TV and the VTR constituting the bidirectional bus system shown in Fig.6.

Figs.8A and 8B show the construction of a bidirectional bus connector constituting the bidirectional bus system shown in Fig.7.

Fig.9 shows the format of a frame of transmission signals.

Fig.10 shows a practical format of a HDOPR.

Fig.11 shows a practical format of command, request and answer frames.

By referring to the drawings, a method for transmission, a method for reception, a method for communication, and a bidirectional bus system according to the present invention will be explained in detail. In the present embodiment, the present invention is applied to an audio, video and visual systems domestic digital bus system (D2B system) prescribed in the so-called IEC publication 1030 and to a home bus system (HBS) prescribed in EIJA ET-2101.

The bidirectional bus system according to the present invention comprises a television receiver (TV) as a device, video tape recorders (VTRs) 20, 30 as devices and a video deck player (VDP) 40, interconnected over a bidirectional bus 1, as shown for example in Fig.6.

The TV 10 encloses, as sub-devices, a tuner 10a for receiving television broadcasting for reproducing video and audio signals, a TV monitor 10b for displaying a picture based upon video signals reproduced by the tuner 10a, while also enclosing, as a sub-device, a switch box 10d for outputting the video signals and/or the audio signals (AV signals) from the tuner 10a to outside or for supplying the input AV signals from outside to the tuner 10a and to the TV monitor 10b, as shown in Fig.6.

The VTR 20 encloses, as sub-devices, a video deck 20a for recording or reproducing the AV signals on or from a magnetic tape and a tuner 20b for receiving television broadcasting for reproducing the AV signals, while also enclosing, as a sub-device, and a switch box 20c for outputting the AV signals from the tuner 20a and the tuner 20b to outside or for supplying the input AV signals from outside to the video deck 20a, as shown in Fig.6.

Similarly to the VTR 20, the VTR 30 also encloses, as sub-devices, a video deck 30a, a tuner 30b and a switch box 30c.

The VDP 40 encloses, as a sub-device, a video player 40a for reproducing the AV signals from the optical disc.

The bidirectional bus system transmits video signals reproduced by the VTR 20, VTR 30 and the VDP 40 to the TV 10, and the picture based on the video signals is displayed on the TV monitor 10b. Specifically, the switch box 10d of the TV 10 and the switch box 10d of the TV 10 are interconnected over an AV signal line L1, and the switch box 10d of the TV 10 and the switch box 20c of the VTR 30 are interconnected over an AV signal line L2, while the switch box 10d of the TV 10 and the video player 40a are interconnected over an AV signal line L3. The AV signal lines L1, L2 and L3 are interconnected around the TV 10, and AV signals reproduced by the VTRs 20 and 30 and the video deck player VDP40 are fed via the AV signal lines L1, L2 and L3 and the switch box 10d to the TV monitor 10b for displaying the picture on the TV monitor 10b. On the other hand, the AV signals reproduced by the video player 40a are supplied to the video deck 20a via the AV signal line L3, switch box 10d, AV signal line L1 and the switch box 20c so as to be

recorded on a magnetic tape, not shown.

Besides, with the present bidirectional bus system, the TV 10 (device) transmits control commands over the bidirectional bus 1 to the VTRs 20, 30 and the video deck player 40 as devices and the video decks 20a, 30a, video player 40a and the switch boxes 20c, 30c enclosed therein, as sub-devices, for controlling these devices and sub-devices. The controlled devices and sub-devices, such as the VTR 20, respond thereto by returning the data indicating their operating states.

With the bidirectional bus system, the TV 10 transmits the requests for the statuses to the VTR 20 over the bidirectional bus 1, for example, data to be displayed on the TV monitor 10b, and the VTR 20 etc. responds thereto by transmitting back the statuses. In addition, with the present bidirectional bus system, the VTR 20, for example, automatically returns the statuses to the TV 10 in the absence of such requests.

Specifically, the TV 10 comprises a micro-processor 12 for controlling the tuner 10a to the switchbox 10d via an inner control bus 11, a user interfacing unit 13 for inputting the user's operational contents to the micro-processor 12, and a bus interfacing circuit 14 for inputting and outputting transmission signals to and from the bidirectional bus 1, as shown in Fig.7. The transmission signals include control commands for controlling other devices or sub-devices and the statuses.

The VTR 20 also includes a micro-processor 22 for controlling the video deck 20a to the switchbox 20c over an internal control bus 21, a user interfacing unit 23 for inputting the user's operational contents to the micro-processor 22 and a bus interfacing circuit 24 for inputting and outputting the transmission signals to and from the bidirectional bus 1, as also shown in Fig.7. The VTR 30 and the VDP 40 also include a microprocessor and a bus interfacing circuit, not shown.

If the user actuates the user interfacing unit 13 in order to view a picture corresponding to the video signals reproduced by the VTR 20 on the TV 10, the micro-processor 12 generates transmission signals responsive to the operational contents, and transmits the generated transmission signals to the VTR 20. The micro-processor 20 of the VTR 20 causes the video deck 20a to reproduce the picture over the internal control bus 21, based upon the transmission signals received by the bus interfacing circuit 24, wile causing the AV signals reproduced by the video deck 20a to be supplied to the switch box 20c.

The user interfacing circuit 13 is made up of an actuating section 13a having a key switch or the like and a display section 13b having light-emitting diodes, as shown in Fig.7. The actuating section 13a routes a signal corresponding to the operational contents entered by the user with a key switch to the micro-processor 12 over the internal control bus 11.

The micro-processor 12 is made up of a read-only memory 12a for storing various programs, a central processing unit (CPU) 12b for executing the programs stored in the ROM 12a, a random access memory (RAM) 12c for storing the results of execution, and an I/O circuit 12d for interfacing with the tuner 10a and the bus interfacing circuit 14, as shown in Fig.12. The programs stored in the ROM 12a include command tables for converting the received control commands into internal control commands for controlling the tuner 10a and the switchbox 10d, programs for displaying the picture corresponding to the received data on the TV monitor 10b.

The CPU 12b executes the program stored in the ROM 12a for producing control commands for controlling the VTR 20 based upon the signals corresponding to the operational contents supplied thereto from the actuating section 13a via the internal control bus 11 and the I/O circuit 12d, and transmits the control command as a frame construction to the bus interfacing circuit 14.

The CPU 12b also routes the statuses etc. as frame structure to the bus interfacing circuit 14, while causing letters etc., corresponding to data received via the bus interfacing circuit 14, such as the statuses of the VTR 20, to be displayed on the TV monitor 10b.

The bus interfacing circuit 14 employs, as an accessing system to the bidirectional bus 1, the so-called carrier sense multiple access with collision detection (CSMA/ CD), and is connected to the bidirectional bus 1 via a connector as prescribed by, for example, the so-called IEC/ SC 48B (secretariat) 202.

Specifically, the connector has two sockets 2, 3, as shown in Fig.8A. The socket 2 has signal contacts 2a, 2b and a ground contact 3c connected internally to signal contacts 3a, 3b of the socket 3 and the ground contact 3c of the socket 3, as shown in Fig.8B. The contacts 2a, 2b are interconnected via a switch 2d and a terminal resistor of e.g. 120 ohms, while the contacts 3a, 3b are interconnected via a switch 3d and a terminal resistor 4.

Such connector is provided in respective devices, such as the TV 10. With the connector provided in the VTR 20, when the plug of the bidirectional bus 1 from the TV 10 and the plug of the bidirectional bus 1 from the VTR 30 are inserted into the sockets 2, 3, the switches 2d, 3d are opened for disconnecting the terminal resistor 4, so that transmission signals from the VTR 10 are routed to the bus interfacing circuit 24 and to the downstream side VTR 30 and VDP 40.

The format of transmission signals transmitted over the bidirectional bus 1 is now explained. The format of the transmission signals is substantially pursuant to the D2B format described in connection with the prior art. Thus the control command for controlling the destination sub-device and the statuses of the VTR 20 are transmitted in a frame structure as shown for example in Fig.4.

That is, each frame is made up of a header field 51 for designating the header indicating the leading end of each frame, a master address field 52 for designating the address of the originating device, a slave address field 53 for designating the destination device, a control field 54 for designating the control bit indicating the communication under the state of having locked or unlocked the destination device, and a data field 55 for designating the control command or the statuses.

The header of the header field 51 is constructed in accordance with the D2B standard explained in connection with the prior art (see Fig.2), and is made up of a start bit for synchronization and a mode bit for specifying the number of bytes of the data field 55.

The address of the originating device of the master address field 52 is constructed in accordance with the D2B standard as explained in connection with the prior art, and is made up of 12-bit master address bits for specifying the address of the originating device and a 1-bit parity.

The address of the destination device of the slave address field 53 is constructed in accordance with the D2B standard as explained in connection with the prior art, and is made up of 12-bit slave address bits for specifying the address of the originating device, a 1-bit parity and a 1-bit acknowledge bit for responding from the destination device.

In the control field 54, 4-bit control bits designating the locked or unlocked state and designating whether the contents of the data field 55 are the control command or the status (data), a 1-bit parity and a 1-bit acknowledge bit, in accordance with the D2B standard as explained in connection with the prior art, are designated. As the control bit, only the master-to-slave codes prescribed in D2B and indicating the writing under the locked state of the command "E"h, h indicating the hexadecimal code, the code "B"h, h indicating the hexadecimal code indicating the writing under the state of data lock, and the code "F"h, indicating only the writing under the data non-locked state, are employed.

In the data field 55, 8-bit data bits, 1-bit end-of-data bit, a 1-bit parity and 1-bit acknowledge bit, are repeated as the occasion may demand, substantially in accordance with the D2B standard as explained in connection with the prior art. If the data bits are data #1, #2, #3, ···, from the leading end, the route selection codes for discrimination between the command frame, request frame and the response frame or the automatic status transmission frame, are designated in prescribed positions, such as the data #1 to #3, as shown in Fig.4.

The route selection code is made up of an 8-bit text header, an 8-bit header operand indicating whether the frame is the command frame, request frame, answer frame or the automatic status transmission frame, and also indicating the communication from a sub-device enclosed in a device to another device, the communication from a device enclosed in a device to a sub-device enclosed in another device or the communication from a device to another device, and an 8-bit sub-device address indicating the address of the originating sub-device (source sub-device address or SSDA) or the address of the destination sub-device or the destination sub-device address or DSDA), as shown in Fig.9. The text header is designated in the data #1 as the code "AB"h for distinction from the OPC "begin 2" (code "BD"h), OPC "begin 1" or OPC "begin 0" ("BB"h) employed in the conventional D2b.

The header operand (HDOPR) is designated at a pre-set position, that is at data #2, and its three bits b_6, b_5, b_4, with b_7 being the MSB, indicate one of the control command, request, answer or automatic status transmitting frames, that is whether the frame in subject is the frame for command, frame for request frame for answer or the frame for automatic transmission. Specifically, $b_6 = 0$, $b_5 = 0$, $b_4 = 0$, referred to hereinafter as $b_6, b_5, b_4 = 0, 0, 0$, indicates the frame for command, $b_6, b_5, b_4 = 0, 0\ 1$ indicates the frome for request, $b_6, b_5, b_4 = 0, 1, 0$ indicates the frame for answer and $b_6, b_5, b_4 = 1, 1, 0$ indicates the frame for automatic transmission, as shown for example in Fig. 5.

The bits b_3, b_2 are used as a service code and, as shown in Fig.10, $b_1 = 0$, $b_0 = 0$ indicate the communication telephony system, $b_1 = 0$, $b_0 = 1$ indicate the AV system (audio video and control system), $b_1 = 1$, $b_0 = 0$ indicate the housekeeping equipment system (HK system) and $b_1 = 1$, $b_0 = 1$ indicate the additional AV system.

The lower two bits, that is bits b_1, b_0 indicate the communication from a sub-device enclosed in a device to another device, referred to herein as communication from a sub-device to a device, the communication from a device to a sub-device enclosed in another device, referred to herein as communication from a device to a sub-device, or the communication from a device to another device. Specifically, $b_1 = 0$, $b_0 = 1$ indicates the communication from a sub-device to a device, $b_1 = 1$, $b_0 = 0$ indicates the communication from a device to a sub-device, and $b_1 = 1$, $b_0 = 1$ indicates the communication from a device to a device, as shown in Fig.10. That is, with the present bidirectional bus system, the communication from a sub-device enclosed in a device to a sub-device enclosed in another device is not performed in this bi-directional bus system. In other words, the HDOPR in which $b_1 = 0$ and $b_0 = 0$ is not employed.

Thus, when performing a command, for example, when transmitting a control command of playing the video deck 20a to the video deck 20a (sub-device) enclosed in the VTR 20 (another device) from the TV 10 (device), the micro-processor 12 of the TV 10 designates the address of the TV 10 in the master address

field 52 as a master address bit, while designating the address of the VTR 20 in the slave address field 53 as the slave address bit and designating a code "E"h indicating the command writing from a master to a slave as a control bit, as shown for example in Fig.6A. In addition, the micro-processor 12 designates the code "AB"h in the data #1 as a text header, while designating the code "06"h indicating that the communication is from a device to a sub-device and indicating that the frame is subject is a frame or command as HDOPR in the data #2, and also designating the address of the video deck 20a in the data #3 as DSDA. Finally, the micro-processor 12 designates the code "C3"h of playing the video deck, for example, in the next following data #4 as OPC, while designating the code "75"h indicating "forward" in the data #4 as OPR.

When the command of transmitting the control command of turning the power source off from the TV 10 (device) to the VTR (device), the micro-processor 12 designates the code indicating that the communication is a command communication from a device to another device in the data #2 as HDOPR, while designating a dummy code, such as "7F"h in the data #3, because the address of the sub-device is not required. This micro-processor 12 also designates a code "A0"h indicating the stand-by in the data #4 as OPC, while designating the code "70"h indicating the "on" state in the data #4 as OPR.

On the other hand, in request communication, that is when requesting the status of the video deck 20a (sub-device) from the TV 10 to the VTR 20, the micro-processor 12 of the TV 10 designates the address of the TV 10 in the master address field 52 as a master address bit, while designating the address of the VTR 20 in the slave address field 53 as a slave address bit and designating a code "E"h indicating the writing under the locked state of the command from the master to the slave in the control field 54 as a control bit, as shown for example in Fig.11B.

The micro-processor 12 also designates a code "AB"h in the data #1 as a text header, while designating a code "16"h indicating that the communication is from the device to another device and also indicating that the frame in subject is a frame for status request in the data #2 as HDOPR, and also designating the address of the video deck 20a in the data #3 as the DSDA. The micro-processor 12 also designates the request code, for example, a code "C#2h of playing the video deck, for example, in the data #4 as OPC, while designating the OPR for this request code in the data #4. When requesting data for displaying letters or the like in, for example, the TV monitor 10b, the microprocessor 12 designates a code "26"h, indicating that the frame is a data request frame and that the communication is from a device to a sub-device, in the data #2 as HDOPR.

The transmission signal having the above-mentioned frame construction is fed from the micro-processor 12 of the TV 10 to the bus interfacing circuit 14. This bus interfacing circuit then detects the presence or absence of the so-called carrier on the bidirectional bus 1 and, if there is no carrier, that is if the bus 1 is not occupied, the interfacing circuit transmits the transmission signal to, for example, the VTRs 20, 30 and the VDP 40 over the bidirectional bus 1. After sending the command frame etc., the bus interfacing circuit 14 immediately halts the transmission of the carrier to open the bidirectional bus 1.

In the command transmission from the TV 10 to the VTR 20, the bus interfacing circuit 24 of the VTR 20 receives the transmission signal over the bidirectional bus 1 and transmits the received transmission signal to a micro-processor 22. The micro-processor 22 executes the program stored in the ROM 22a and detects the route selection code inserted at the preset position in the data field 55 from the transmission signal. The micro-processor 22 then detects, based on the route selection code, whether the frame in subject is the command frame, status request frame, data request frame, answer or response frame or the frame for automatic status transmission.

The micro-processor 22 detects, based upon the route selection code, whether the communication is from a sub-device enclosed in a device to another device, from a device to a sub-device enclosed in another device, or from a deice to another device.

Specifically, the micro-processor 22 detects, based upon the master address bit of the master address field 52 of the transmission signal and the slave address bit of the slave address field 53, that the transmission signal is the signal transmitted to it from the TV 10, while detecting, based on the code of the control field 54, such as by the code "E"h, that the transmission signal is the command writing from a master to a slave. In such case, the micro-processors of the VTR 30 and the VDP 40 detect that, since the lave address is not its address, the communication is directed to it, and thus does not perform an operation associated with the transmission signal.

The micro-processor 22 also detects, based upon the text header designated in the data #1 of the data field 55, for example, by the code "AB"h, that the code is not OPC "begin 2" (code "BD"h), OPC "begin 2" ("BC"h) nor OPC "begin 2" ("BB"h). Besides, based upon the HDPOR designated in the data #2, the micro-processor 22 detects that the frame in subject is the command frame if the bit b_6, b_5, b_4 are 0, 0, 0 (b_6, b_5, b_4 = 0, 0, 1), the frame in subject is the status request frame if the bit b_6, b_5, b_4 are 0, 0, 1, the frame in subject is the data request frame if the bit b_6, b_5, b_4 are 0, 1, 0, the frame in subject is the answer or response frame if the bit b_6, b_5, b_4 are 0, 1, 1 and that the frame is the automatic status transmission frame if b_6, b_5, b_4 are 1, 0, 0.

That is, with the present bi-directional bus sys-

tem, the transmitting device inserts the HDOPR for discrimination of the command frame from the request frame in the data #2 of the data field 55 and transmits these frames. The destination device or receiving device discriminates the command frame from the request frame, based upon the HDOPR, for simplifying the processing software and the hardware of the destination device, such as the VTR 20, as compared to those of the conventional system. Besides, since the HDOPR is not inserted at the trailing end of the frame, the possibility of the HDOPR dropout may be lowered in order to prevent the request frame from being mistakenly judged to be the command frame.

The micro-processor 22 also detects that the communication is from a device to another device, from a sub-device to a device and from a device to a device if the lower two bits are 1, 0 (b_1 = 1, b_0 = 0), 0, 1 and 1, 1, respectively. That is, discrimination can be made if the transmission signals pursuant to the conventional D2B are transmitted over the same bidirectional bus 1.

On the other hand, if the communication is from a device to a sub-device or from a sub-device to a device, the microprocessor 22 recognizes that the DSDA and SSDA are designated in the data #3, respectively. The micro-processor 22 recognizes that, if the communication is from a device to a device, the micro-processor 22 recognizes that the data #3 is the dummy code "7F"h. Based upon the DSDA specified in, for example, the data #3, the micro-processor 22 determines that the control is for e.g. the video deck 20a.

The equipment (devices), such as the VTR 20, include command tables for converting the control command into the internal control command for controlling the sub-device, for respective sub-devices provided or enclosed in the devices. Based upon these command tables, the same control commands are converted or decoded into the internal control commands having different control contents from one type of the controlled sub-device to another. Specifically, a deck/player command table for the video deck 20a and the tuner command table for the tuner 20b are stored in the ROM 22a of the micro-processor 22. Based upon these command tables, the micro-processor 22 converts or decodes the commands specified in data #4 and #5 of the data field 55 into the internal control command for controlling the video deck 20a and the switch box 20c and, based upon the internal control command, controls the video deck 20a and the switch box 20c via the internal control bus 21. For example, the OPC of the control command being the code "C0"h indicates the repeat, band control, contrast control and volume control for a deck/ player command, a tuner command, a video command and an audio command, respectively. In other words, a command table determined by the default value of the sub-device designated by the DSDA is employed, and the code of the control command may be employed in common depending upon the sub-device type, thereby making it possible to shorten the control command length.

If, for example, the DSDA is the video deck 20a, the OPC of the control command is the code "C3"h and the OPR is the code "75"h, the micro-processor 22 decodes the control command into the internal control command which stands for "play" and "forward", based upon the deck/ player command table, and controls the video deck 20a for executing the reproducing operation over the internal control bus 21. Besides, the microprocessor 22 causes the AV signals from the video deck 20a to be supplied via the switch box 20c to the switch box 10d of the TV 10. Thus the communication from the TV 10 (device) to the video deck 20a of the VTR 20 (sub-device) is performed, so that the picture corresponding to the AV signals reproduced by the VTR 20 can be viewed on the TV 10.

On reception of the command frame, as described above, the micro-processor 22 transmits the answer (response) frame to the TV 10, as the response to the command, within a pre-set time as from reception of the command frame.

Specifically, the micro-processor 22 designates the address of the VTR 20 in the master address field 52 as a master address bit, while designating the address of the TV 10 in the slave address field 53 as the slave address bit, and designating a code "E"h indicating the command writing from the master to the slave in the control field 54 as a control bit, as shown for example in Fig.11. Besides, the micro-processor 12 designates a code "AB"h in the data #1 as the text header, while designating a code "35"h, indicating that the frame is the answer frame and that the communication is from a sub-device to a device in the data #2, as HDOPR, while designating the address of the video deck 20a as the SSDA. The micro-processor 12 also designates the code "C3"h indicating the play in the next following data #4 as the OPC, while designating a code "75"h indicating "forward" in the data #5 as the OPR and designating an answer terminator in the data #6. The micro-processor 22 transmits the answer frame to the bus interfacing circuit 24, which then transmits (returns) the transmission signal of the frame to the TV 10 over the bidirectional bus 1. After transmitting the answer frame, the frame interfacing circuit 24 immediately halts carrier transmission to open the bidirectional bus 1. The terminator of the answer frame is made up of, for example, 8 bits. The code "10"h indicates the absence of the ability of executing the command (not implemented), code "11"h indicates the presence of the ability of executing the command but the absence of such ability at present (reject), code "12"h indicates the inability to give judgement on executability at the time point

of reception (busy), and the code "13"h indicates the completion of the execution of the command (completed).

That is, with the conventional bidirectional bus system, a request frame has to be sent in order to confirm the operating state of the VTR after sending the command frame for sending the control command to the VTR. On the other hand, since the route selection information is present only in the command frame, it is necessary to send the answer frame. In addition, for unlocking the VTR, it is necessary to send the end command frame. With the bidirectional bus system of the present invention, since the VTR 20 on reception of the command frame sends the answer frame having the route selection code to the TV 10 to return the status, the request frame as well as the end command frame may be deleted. In other words, by inserting the HDOPR discriminating the command frame, request frame, answer frame and the automatic status transmission frame in the data #2 of the data field, it is possible for the TV 10 and the VTR 20 to send these frames by option, that is without regard to other frames. With the present system, the amount of the traffic on the bidirectional bus 1 may be diminished to improve the transmission efficiency. Besides, the communication protocol may be simplified. With the conventional bidirectional bus system, the bidirectional bus 1 is occupied for a longer time compared to the rate of communication until returning an answer to a request. With the present bidirectional bus system, since the frames may be sent out by option, the bidirectional bus 1 may be prevented from being occupied for long, with the result that the amount of the traffic may be diminished.

On the other hand, if the VTR 20 receives the status request frame from the VTR 10, it returns an answer frame, shown in Fig.11C, to the TV 10 for answering the status request.

Even in the absence of request, the VTR 20 automatically sends out an automatic status transmission frame, in which the HDOPR is set to a code "43"h, to the TV 10.

It is to be noted that the present invention is not limited to the above-described embodiments, and may be applied to a bidirectional bus system for controlling AV equipment other than D2B or HBS.

Claims

1. A method for transmission by a bidirectional bus system in which plural devices performing the communication of a command and a request are interconnected over a bidirectional bus, comprising the steps of

   constituting a frame of a transmission signal on said bidirectional bus from an address field for designating addresses of communicating devices and a data field for designating the command or request to be transmitted, and

   inserting the discriminating information for discrimination between said command and the request at a pre-set position in said data field,

   the transmission signals having said discrimination information inserted therein being transmitted over said bidirectional bus to other devices.

2. The method of transmission as claimed in claim 1 further comprising the step of

   designating said command, request, answer to the request or the device status in said data field.

3. The method of transmission as claimed in claim 2 wherein said discrimination information is the information discriminating the command, request, answer and automatic status transmission from one another.

4. The method of transmission as claimed in claim 1, 2 or 3, further comprising the step of

   inserting the information indicating the device communication configuration at a pre-set position in said data field, said device communication configuration being one of the communication from a sub-device to another device, the communication from a device to a sub-device of another device and the communication from a device to another device, with the exclusion of the communication from a sub-device to a sub-device of another device.

5. A method for reception in a bidirectional bus system in which plural devices performing the communication of a command and a request are interconnected over a bidirectional bus, comprising the steps of

   receiving a transmission signal over said bidirectional bus, said transmission signal having a frame structure comprised of an address field for designating addresses of communicating devices and a data field for designating the command or request to be transmitted, said transmission signal having the discrimination information inserted at a pre-set position in said data field, said discrimination information making discrimination between the command and the request from each other, and

   detecting said discrimination information from said transmission signal,

   recognition of whether the contents of said data field is the command or the realest being made on the basis of said discrimination information.

6. The method of reception as claimed in claim 5 wherein
the command, request, answer to the request or the device status is designated in said data field.

7. The method of reception as claimed in claim 6 wherein
said discrimination information is the information for discriminating the command, request, answer and the automatic status transmission from one another.

8. A communication system employing a bidirectional bus system in which plural devices performing the communication of a command and a request are interconnected over a bidirectional bus, wherein
a source device constitutes a frame of a transmission signal on said bidirectional bus by an address field for designating addresses of communicating devices and a data field for designating the command or the request to be transmitted, inserts the discrimination information at a pre-set position of the data field for discriminating the command and the request from each other, and sends out the transmission signal with the discrimination information inserted therein over the bidirectional bus, and wherein
a destination device receives the transmission signal over the bidirectional bus, detects the discrimination information from the transmission signal and recognizes whether the contents of the data field is the command or the request based upon the discrimination information.

9. The communication system as claimed in claim 8 wherein
the source device designates the command, request, answer to the request or the device status in said data field and sends the transmission signal having the discrimination information inserted therein, said discrimination information being the information discriminating the command, request, answer to the request or the device status from one another, and wherein
said destination device discriminating whether the contents of the data field are the command, request, answer to the request or the device status based upon the discrimination information.

10. A bidirectional bus system comprising a plurality of devices performing the communication of the command or the request, wherein said devices comprise
transmission signal forming means for constituting a frame by an address field for designating addresses of communicating devices and a data field for designating the command or the request to be transmitted, and inserting the discrimination information at a pre-set position of the data field for discriminating the command and the request from each other to form a transmission signal,
bus outputting means for outputting the transmission signals formed by said transmission forming means over the bidirectional bus,
bus inputting means for receiving the transmission signal over the bidirectional bus, and
control means for detecting the discrimination information from the transmission signal received by the bus inputting means and recognizing whether the contents of the data field is the command or the request based upon the discrimination information,
said devices being interconnected over said bidirectional bus.

11. The bidirectional bus system as claimed in claim 10 wherein
said transmission signal forming means designates the command, request, answer to the request or the device status in said data field, and inserts the discrimination information at a pre-set position in the data field to form the transmission signal, said discrimination signal discriminating the command, request, answer and automatic status transmission from one another,
said control means discriminating whether the contents of the data field are the command, request, answer of the automatically sent status based upon said discrimination information.

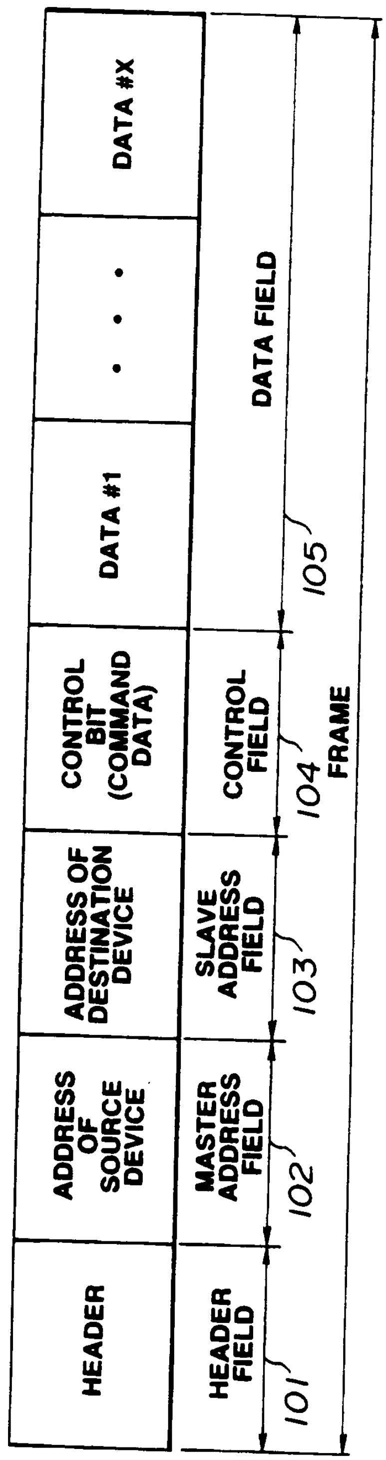

FIG.1
(PRIOR ART)

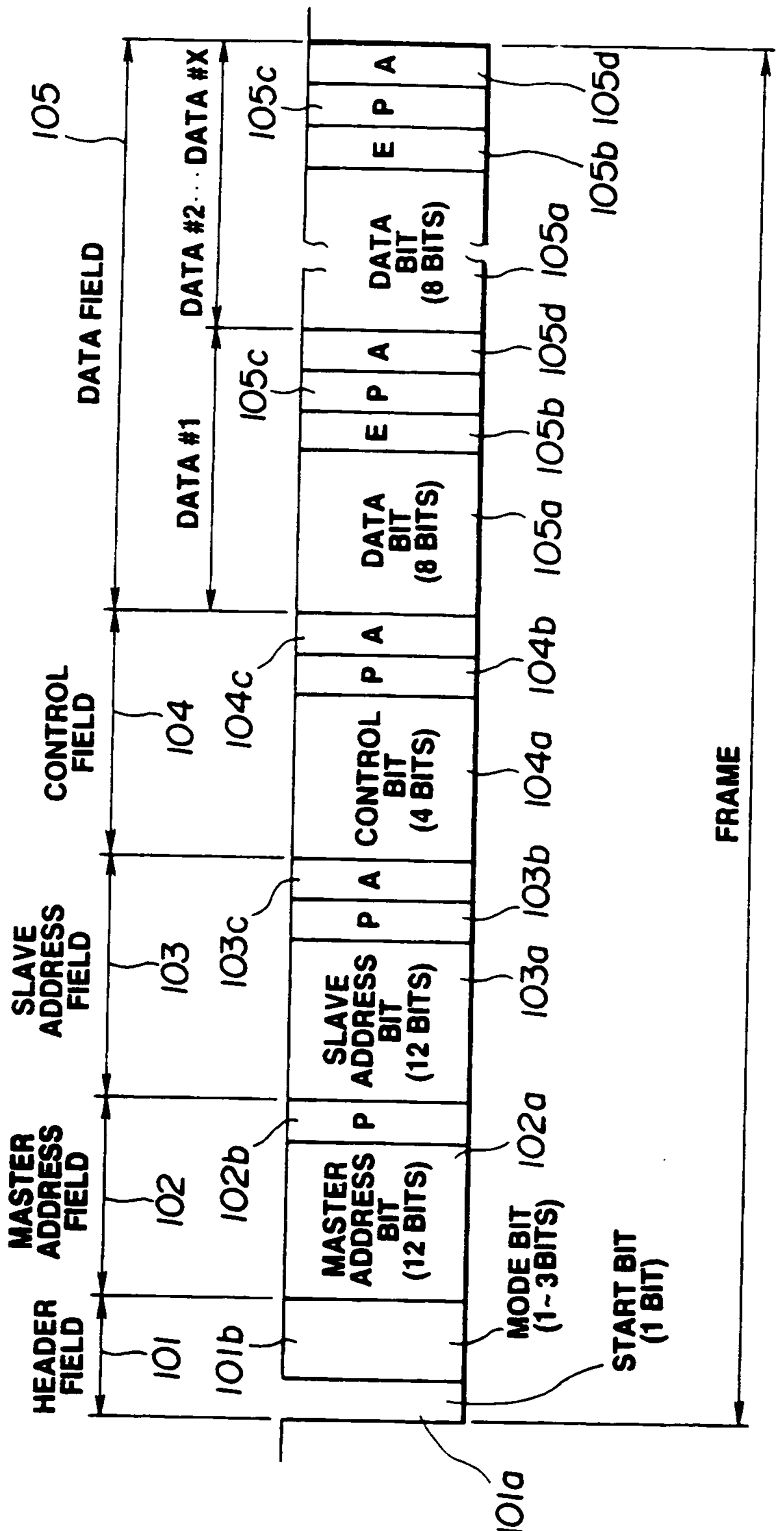

FIG.2
(PRIOR ART)

CODE	b3	b2	b1	b0	MESSAGE DIRECTION	FUNCTION	LOCK STATE
"0"h	0	0	0	0	FROM SLAVE TO MASTER	READ-IN SLAVE STATE	NON-LOCK
"1"h	0	0	0	1		UNDEFINED (FOR FUTURE EXTENSION)	
"2"h	0	0	1	0		READ-IN SLAVE STATE	LOCK
"3"h	0	0	1	1		DATA READ-IN	LOCK
"4"h	0	1	0	0		READ-IN LOCK ADDRESS (LOWER 8 BITS)	NON-LOCK
"5"h	0	1	0	1		READ-IN LOCK ADDRESS (LOWER 4 BITS)	NON-LOCK
"6"h	0	1	1	0		READ-IN SLAVE STATE	UNLOCK
"7"h	0	1	1	1		DATA READ-IN	UNLOCK
"8"h	1	0	0	0	FROM MASTER TO SLAVE	MEMORY ADDRESS WRITE	LOCK
"9"h	1	0	0	1		UNDEFINED (FOR FUTURE EXTENSION)	
"A"h	1	0	1	0		COMMAND WRITE	LOCK
"B"h	1	0	1	1		DATA WRITE	LOCK
"C"h	1	1	0	0		UNDEFINED (FOR FUTURE EXTENSION)	
"D"h	1	1	0	1		UNDEFINED (FOR FUTURE EXTENSION)	
"E"h	1	1	1	0		COMMAND WRITE	UNLOCK
"F"h	1	1	1	1		DATA WRITE	UNLOCK

FIG.3
(PRIOR ART)

Bit number	Meaning	
7	Always 0	
6	Reserved for future standardization, "1"	
5, 4	Source service code	00 : CT 01 : AV/C 10 : HK 11 : reserved
3, 2	Destination service code	00 : CT 01 : AV/C 10 : HK 11 : reserved
1	1/0 without/with SSDA	
0	1/0 without/with DSDA	

FIG.4
(PRIOR ART)

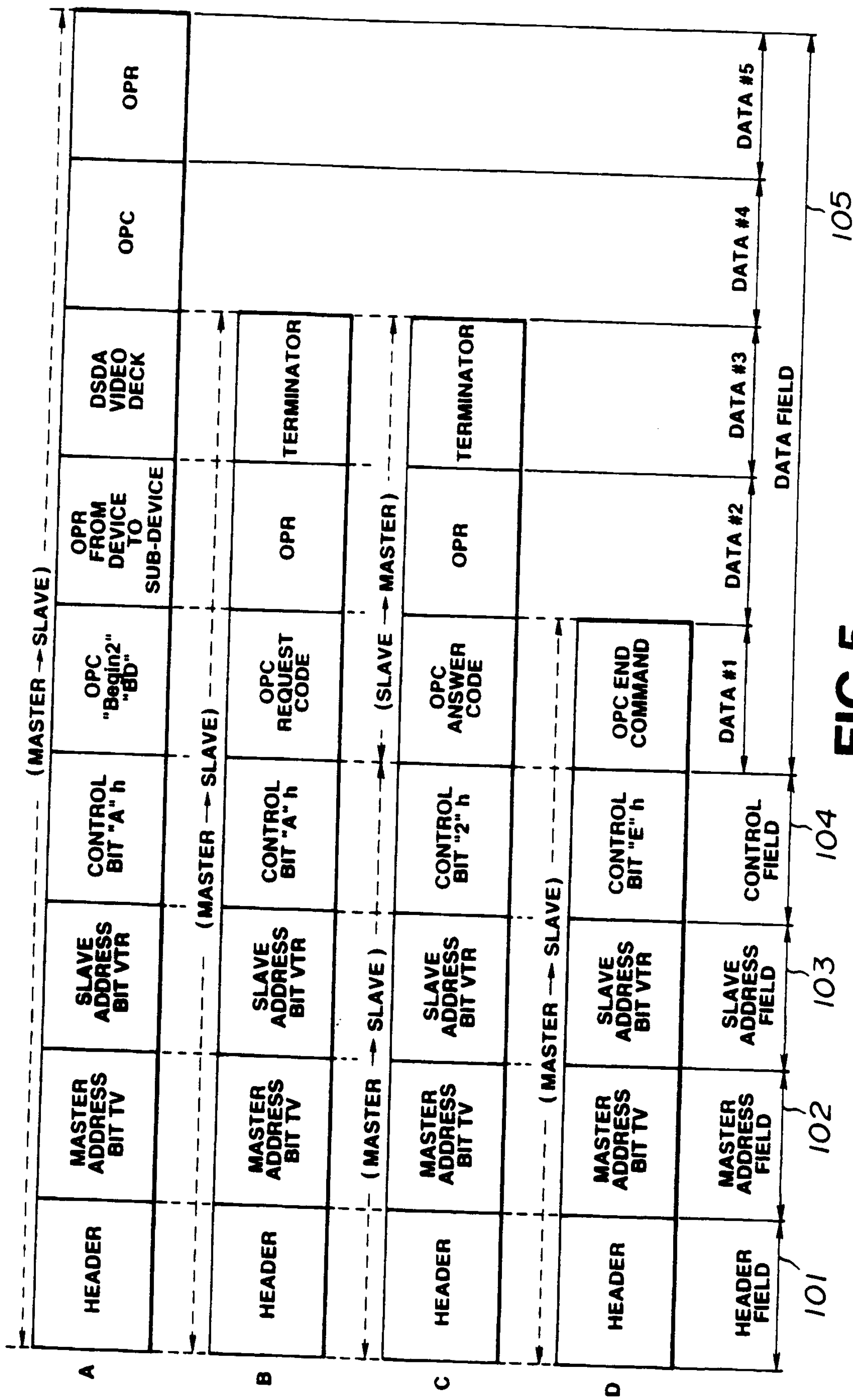

FIG.5 (PRIOR ART)

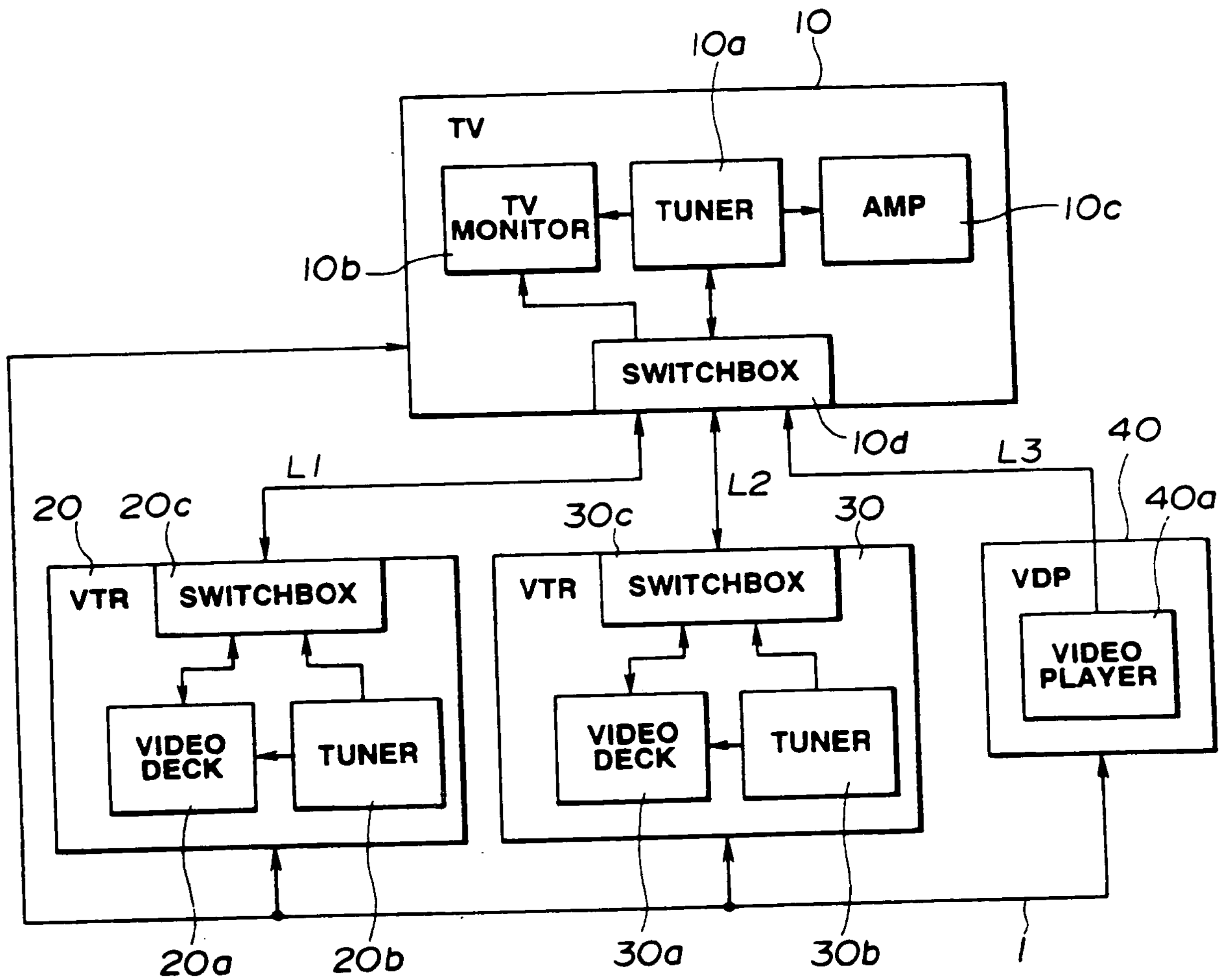
10
10a
TV
TV MONITOR
TUNER
AMP
10c
10b
SWITCHBOX
10d
L1
L2
L3
40
40a
20
20c
VTR
SWITCHBOX
30c
30
VTR
SWITCHBOX
VDP
VIDEO PLAYER
VIDEO DECK
TUNER
VIDEO DECK
TUNER
20a
20b
30a
30b
1

FIG.6

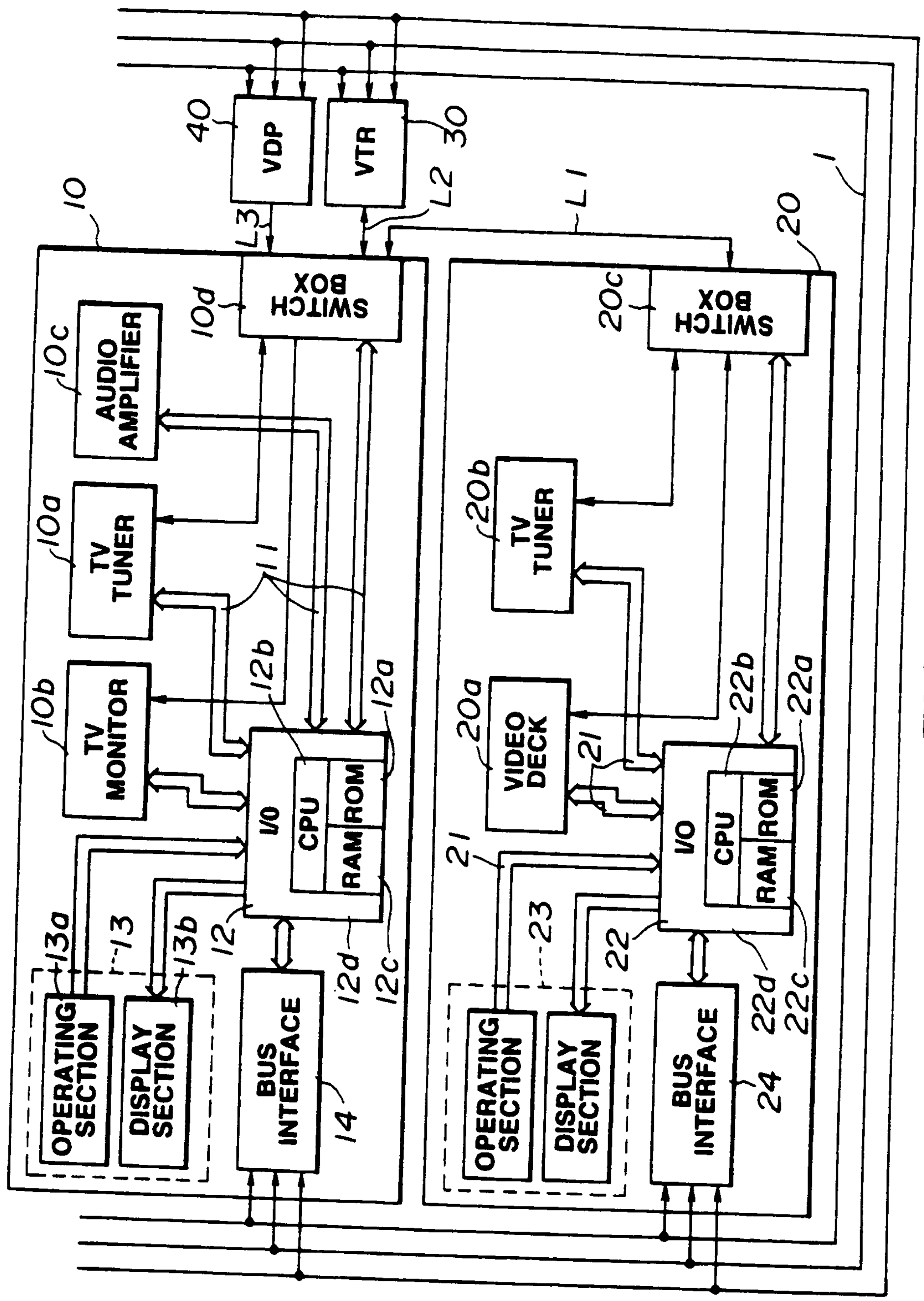
10
40
VDP
VTR
30
L3
L2
L1
1
SWITCH BOX
10d
AUDIO AMPLIFIER
10c
TV TUNER
10a
TV MONITOR
10b
11
12b
12a
I/O
CPU
RAM
ROM
12
12d
12c
13a
13
13b
OPERATING SECTION
DISPLAY SECTION
BUS INTERFACE
14
20
SWITCH BOX
20c
TV TUNER
20b
VIDEO DECK
20a
21
22b
22a
22
22d
22c
23
24

FIG.7

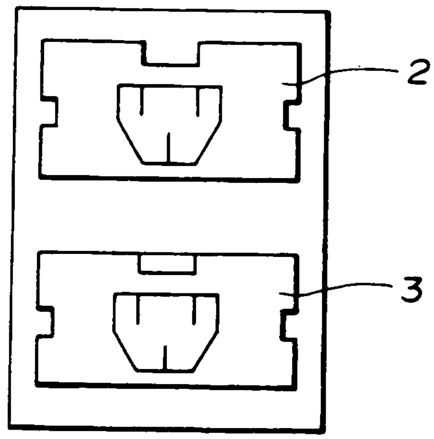

FIG.8A

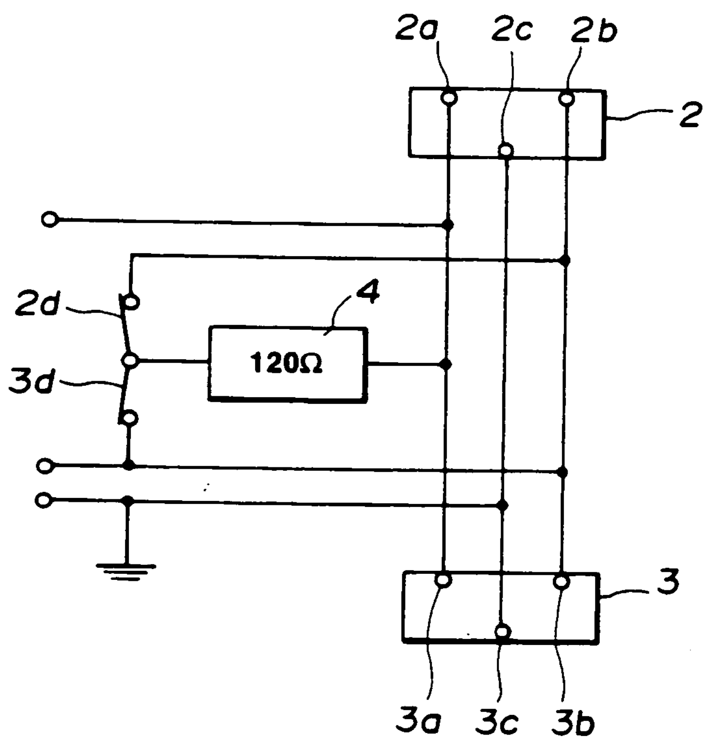

FIG.8B

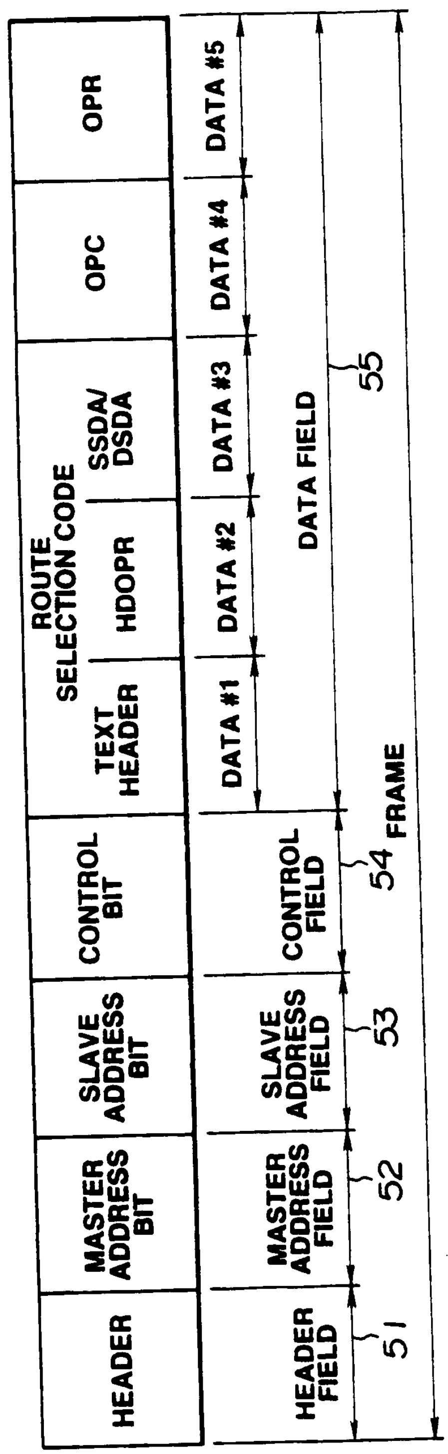
HEADER
MASTER ADDRESS BIT
SLAVE ADDRESS BIT
CONTROL BIT
ROUTE SELECTION CODE
TEXT HEADER
HDOPR
SSDA/ DSDA
OPC
OPR
HEADER FIELD
51
MASTER ADDRESS FIELD
52
SLAVE ADDRESS FIELD
53
CONTROL FIELD
54
DATA #1
DATA #2
DATA #3
DATA #4
DATA #5
DATA FIELD
55
FRAME

FIG.9

MSB / LSB

b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
0	COMMAND, REQUEST ANSWER AND AUTOMATIC STATUS TRANSMISSION $b_6 b_5 b_4$: 000 : COMMAND 001 : STATUS REQUEST 010 : DATA REQUEST 011 : ANSWER 100 : AUTOMATIC STATUS TRANSMISSION 101 : / 110 : / 111 : UNDEFINED			SERVICE CODE b3b2 : 00 : COMMUNICATION TELEPHONY 01 : AV 10 : HOUSEKEEPING 11 : ADDITIONAL AV		SSDA/DSDA/ DEVICE DESIGNATION b1b0 : 00 : UNUSABLE 01 : SSDA 10 : DSDA 11 : DEVICE	

FIG.10

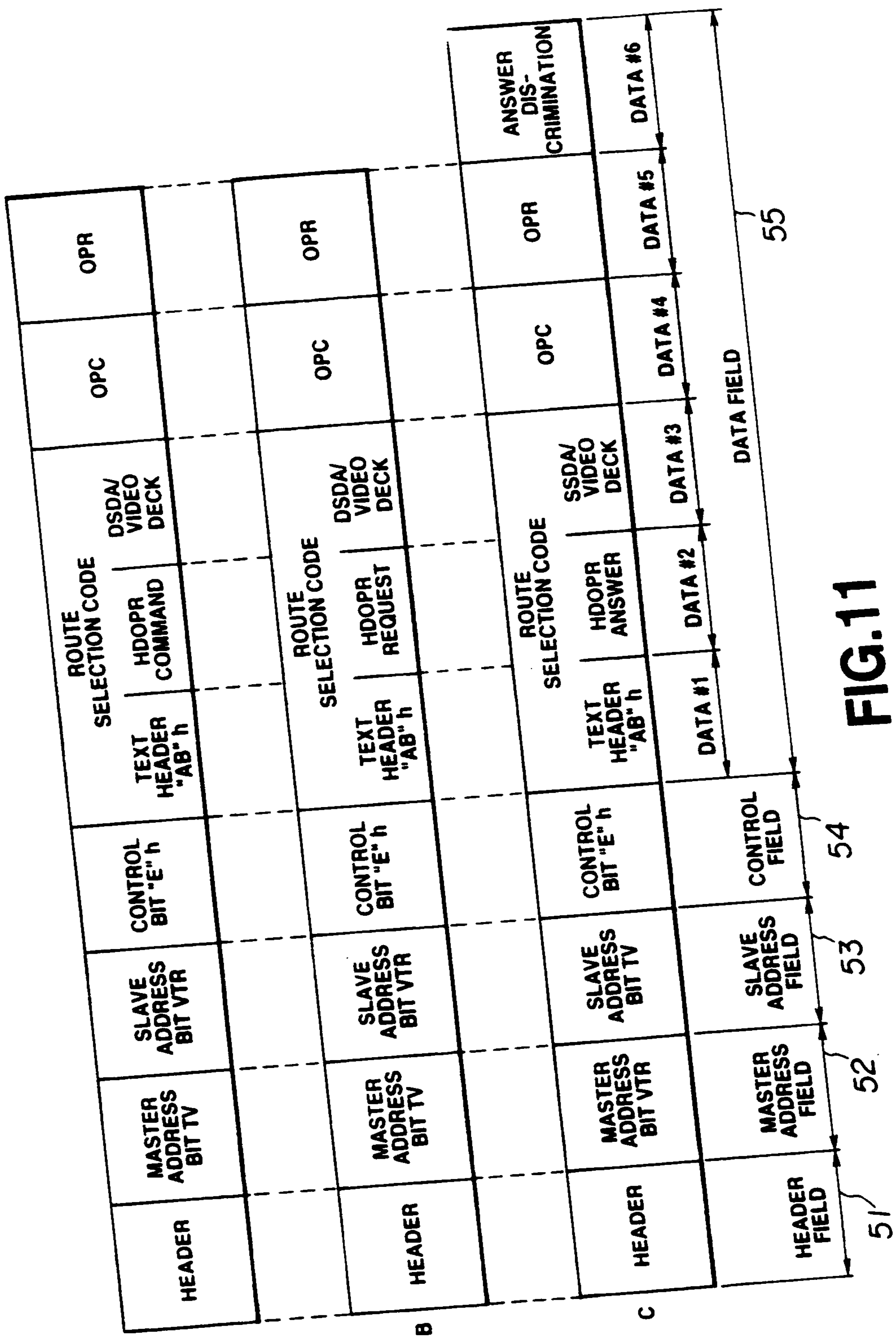
A
HEADER
MASTER ADDRESS BIT TV
SLAVE ADDRESS BIT VTR
CONTROL BIT "E" h
ROUTE SELECTION CODE
TEXT HEADER "AB" h
HDOPR COMMAND
DSDA/ VIDEO DECK
OPC
OPR
B
HEADER
MASTER ADDRESS BIT TV
SLAVE ADDRESS BIT VTR
CONTROL BIT "E" h
ROUTE SELECTION CODE
TEXT HEADER "AB" h
HDOPR REQUEST
DSDA/ VIDEO DECK
OPC
OPR
C
HEADER
MASTER ADDRESS BIT VTR
SLAVE ADDRESS BIT TV
CONTROL BIT "E" h
ROUTE SELECTION CODE
TEXT HEADER "AB" h
HDOPR ANSWER
SSDA/ VIDEO DECK
OPC
OPR
ANSWER DIS- CRIMINATION
DATA #1
DATA #2
DATA #3
DATA #4
DATA #5
DATA #6
HEADER FIELD
MASTER ADDRESS FIELD
SLAVE ADDRESS FIELD
CONTROL FIELD
DATA FIELD
51
52
53
54
55

FIG.11

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(54) **Method for communication in a bidirectional bus system**

(57) A method for signal transmission and reception by a bidirectional bus system in which plural devices performing the communication of a command and a request are interconnected over a bidirectional bus is disclosed. The method includes the steps of constituting a frame of a transmission signal on the bidirectional bus from an address field for designating addresses of communicating devices and a data field for designating the command or request to be transmitted, and inserting the discriminating information for discrimination between the command and the request at a pre-set position in the data field. The transmission signals having the discrimination information is transmitted over the bidirectional bus to other devices. A communication system employing such bidirectional bus system is also disclosed.

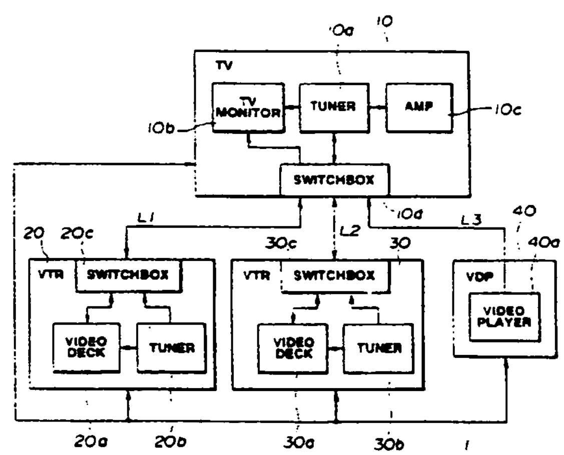

FIG.6

EP 0 651 588 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 7924

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 423 730 (MATSUSHITA) * column 3, line 2 - line 44; figure 1 * * column 13, line 49 - column 15, line 49 * ---	1-3,5-11	H04Q11/04 H04L12/28
A	MINI MICRO CONFERENCE RECORD, May 1984 NEW YORK US, pages 1-10, R.L. MITCHELL 'Super serial systems' * page 2, right column, line 44 - page 5 * -----	1-11	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H04L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 March 1996	Staessen, B

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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